

MCGINN & GIBB, PLLC
A PROFESSIONAL LIMITED LIABILITY COMPANY
PATENTS, TRADEMARKS, COPYRIGHTS, AND INTELLECTUAL PROPERTY LAW
8321 OLD COURTHOUSE RD, SUITE 200
VIENNA, VIRGINIA 22182-3817
TELEPHONE (703) 761-4100
FACSIMILE (703) 761-2375

**APPLICATION
FOR
UNITED STATES
LETTERS PATENT**

APPLICANT: Asai et al.

FOR: DATABASE SYSTEM

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SPECIFICATION

TITLE OF THE INVENTION

DATABASE SYSTEM

BACKGROUND OF THE INVENTION

5 Field of the Invention

This invention relates to a database system, a data-storage control system, a database server and a method of controlling operation of the database server.

Description of the Related Art

- 10 A database system includes a command execution unit and a search unit for searching a database in which data has been stored. If a command is applied to the command execution unit, the command execution unit applies a search command to the search unit, which responds by
- 15 searching the database. Data representing the search results is supplied from the search unit to the command execution unit so that the data is output.

- In a case where a database search is conducted using a search technique different from the search
- 20 technique of the search unit connected to the command execution unit, another search unit must be used in place of the search unit connected to the command execution unit. However, the procedure through which commands and data are exchanged by the command execution
- 25 unit and search unit is known only to the party that manufactured the command execution unit and search unit. This means that substituting another search unit for the search unit connected to the command execution unit is

not conceivable. In order to conduct a database search using a search technique different from that of a search unit connected to a command execution unit, both the command execution unit and the search unit must be
5 modified in accordance with the search technique.

If data is image data or the like, image data having a variety of expression formats, such as image data representing an image of the original size or image data representing a thumbnail image, is stored in a
10 database. If both original-image data and thumbnail-image data have been stored in a database, applying a search command makes it possible to find the corresponding original-image data or thumbnail-image data by a search.

15 However, if image data having an expression format specified by a search command does not exist in a case where only one type of image data, namely the original-image data or thumbnail-image data, has been stored in the database, this image data cannot be found even
20 though the image data having the other expression format is present. For example, when a search command for image data that is thumbnail-image data has been applied, a hit regarding original-image data will not be obtained even though original-image data corresponding
25 to this thumbnail-image data exists. This means that the search command must be applied again upon changing the expression format. In other words, a search command for original-image data must be applied again.

Furthermore, if the result of a search is failure to obtain a hit in a particular database, the same search command must be applied to other databases.

DISCLOSURE OF THE INVENTION

5 Accordingly, an object of the present invention is to so arrange it that a search unit can be exchanged by disconnecting it from a command execution unit.

Another object of the present invention is to make it unnecessary to re-apply a search command upon
10 changing the expression format thereof.

A further object of the present invention is to so arrange it that merely applying a single search command makes it possible even for other database servers to conduct a search.

15 A database system according to a first aspect of the present invention comprises a database in which data has been stored in accessible form; a search device (search means) for accessing the database in accordance with an applied search command and searching data that
20 has been stored in the database; a command execution device (command execution means), to which a command is entered, for applying a search command to the search device in accordance with this entered command; and a first interface for separably connecting the search
25 device and the command execution device.

In accordance with the first aspect of the present invention, a first interface is provided. Since the first interface connects the search device and the

command execution device in such a manner that the two
can be separated from each other, the search device
connected to the command execution device can be
disconnected and a different search device can be
5 connected to the command execution device. This means
that a search device employing a desired search
technique can be connected to the command execution
device.

Preferably, the database further comprises a
10 storage device for storing data readably; a storage
controller for accessing the storage device and reading
data that has been stored in the storage device or
writing data to the storage device in accordance with an
applied read/write command; and a second interface for
15 separably connecting the storage controller and the
command execution device. In this case, the command
execution device would apply the read/write command to
the storage controller in accordance with the entered
command (or in accordance with the results of the search
20 conducted by the search device).

A second interface is provided. Since the second
interface connects the storage controller and the
command execution device in such a manner that the two
can be separated from each other, the storage controller
25 connected to the command execution unit can be
disconnected and a different storage controller can be
connected to the command execution device. This means
that a desired storage controller can be connected to

the command execution device.

A data storage control system according to a second aspect of the present invention comprises an expression-format changing device (expression-format changing means) for changing applied data to data having a prescribed expression format; a storage device for storing data in readably; a storage controller for accessing the storage device and reading data that has been stored in the storage device or writing data, the expression format of which has been changed by the expression-format changing device, to the storage device in accordance with an applied read/write command; and a command execution device, to which an applied command is entered, for applying a read/write command to the storage controller in accordance with the entered command.

In accordance with the second aspect of the present invention, applied data is changed to data of a prescribed expression format by the expression-format changing device. Data whose expression format has been changed is written to the storage device by the storage controller. As a result, data having a prescribed expression format is written to the storage device. If a command for applying a search command having the prescribed expression format written to the storage device is applied, then data that has been stored in the database can be found.

Data generating means (a data generating device)

may be provided. If a command is applied for the purpose of extracting data having a specific expression format from data that has been stored in the storage device, this data (e.g., thumbnail-image data) having
5 the specific expression format does not exist but data that is substantially the same (e.g., original-image data) except for the expression format does exist, the data generating device generates data having the specific expression format from the data that is
10 substantially the same.

An interface for separably connecting the expression-format changing device, the storage control device and the command execution device may be provided.

A database server according to a third aspect of
15 the present invention comprises a first receiving device for receiving a search command transmitted via a network; a search device for searching the database based upon the search command received by the first receiving device; a transmitting device for transmitting
20 the search command, which has been received by the first receiving device, to another database server; a second receiving device for receiving data, which represents search results, transmitted from the other database server in accordance with transmission of the search
25 command to the other database server by the transmitting device; and an output device for outputting, in mutually correlated form, data representing search results obtained by the search by the search device and data

representing search results received by the second receiving device.

The third aspect of the present invention provides also an operation control method applied to the above-described database server. Specifically, the third aspect of the invention provides a method of controlling operation of a database server, comprising the steps of receiving a search command transmitted via a network; searching a database based upon the received search command; transmitting the received search command to another database server; receiving data, which represents search results, transmitted from the other database server in accordance with transmission of the search command to the other database server; and outputting, in mutually correlated form, data representing search results obtained by the search and data representing received search results.

In accordance with the third aspect of the present invention, a search command transmitted via a network is received and a database is searched based upon the received search command. The received search command is transmitted to other database servers as well.

Another database server that has received the search command conducts a database search to find the relevant data. The data that is found is sent from the server of the other database to the database server that transmitted the search command.

Data transmitted from the server of the other

database and found as a result of the search by this
other database server is received by the database server
that received the search command. The data found by the
server of the other database is correlated with the data
5 found by the search conducted by the database that
received the search command via the network. The
correlated data is output.

Thus, merely by receiving a single search command,
a search can be conducted not only by a single database
10 server that received the search command but also by
other database servers.

Other features and advantages of the present
invention will be apparent from the following
description taken in conjunction with the accompanying
15 drawings, in which like reference characters designate
the same or similar parts throughout the figures
thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates the relationship between a
20 client computer and database servers;

Fig. 2 is a block diagram illustrating the
electrical construction of a database server;

Figs. 3a and 3b illustrate an example of an
attribute table;

25 Fig. 4 illustrates a table of expression formats;

Fig. 5 illustrates the relationship between images
of stored expression formats and image identification
numbers;

Fig. 6 is a flowchart illustrating processing for conducting a search of image data;

Fig. 7 is a flowchart illustrating processing for command execution; and

5 Fig. 8 is a flowchart illustrating processing for data acquisition.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will now be described with reference to the drawings.

10 Fig. 1, which illustrates a preferred embodiment of the invention, shows the relationship between a client computer 1 and a plurality of database servers 2, 3 and 10 connected to a network.

The client computer 1 and database servers 2, 3 and 15 10 are capable of communicating with one another via the network, and image data has been stored in each of the database servers 2, 3 and 10.

In this embodiment of the invention, the user of the client computer 1 enters a search command and a 20 command that designates that database server that is to conduct a search. (It is assumed here that the first database server 10 has been designated.) The entered search command is transmitted from the client computer 1 to the designated first database server 10. The latter 25 receives the search command and its image data is searched in accordance with the received search command.

The search command entered from the client computer 1 is transferred further to the second database server 2

and third database server 3 besides the first database server 10 designated by the client computer 1. Search processing is executed by the second database server 2 and third database server 3 and image data found by the
5 search is transmitted from the second database server 2 and third database server 3 to the first database server 10.

Data retrieved by the search of database servers 2, 3 and 10 is transmitted from the first database server
10 10 to the client computer 1.

The foregoing will become clearer from the description that follows.

Fig. 2 is a block diagram illustrating the electrical construction of the first database server 10.
15 The second database server 2 and third database server 3 are constructed in a manner similar to that of the first database server 10.

The first database server 10 includes a large-capacity hard disk 19 in which image data representing
20 images of a large number of frames has been stored. Image data is read from and written to the hard disk 19 by a data storage unit 18.

The first database server 10 includes a relational database management system (RDBMS) 16 in which attribute
25 information regarding the image data that has been written to the hard disk 19 has been stored in table form. The attribute information in the RDBMS 16 is searched by a search unit 15.

Figs. 3a and 3b illustrate an attribute table that has been stored in the RDBMS 16. Fig. 3b illustrates the attribute table of Fig. 3a in greater detail.

As shown in Fig. 3a, attribute information
5 contained in the attribute table includes the
identification number (No.) of an image represented by
image data that has been stored in the large-capacity
hard disk 19, the telephone number (Tel) of the owner
(the copyright owner) of the image, the age (Age) of the
10 owner of the image, and the name (Name) of the owner of
the image, etc.

As shown in Fig. 3b, these items of attribute
information have been stored in further detail in
correspondence with identification numbers. By
15 specifying an identification number, one can ascertain
the image data corresponding to this identification
number and detailed attribute information concerning the
image represented by this image data.

The search command transmitted from the client
20 computer 1 as mentioned above is received by a command
receiving unit 11 via the network. The received search
command is input to a command resending unit 12.

The search command is transmitted to the second and
third database servers 2, 3 in addition to the first
25 database server 10 by the command resending unit 12.
Image-data search processing is executed by the second
and third database servers 2, 3 in a manner similar to
that of the first database server 10. Image data

retrieved by the search processing is sent back to the first database server 10 from the second and third database servers 2, 3.

The search command received by command receiving unit 11 is input also to a command execution unit 13 via the command resending unit 12. The command execution unit 13 applies the search command of the RDBMS 16 to the search unit 15. The search command from the command execution unit 13 is input to the search unit 15, whereby processing is executed to search the RDBMS 16. Provided between the command execution unit 13 and search unit 15 is a search interface 14 for connecting the command execution unit 13 and search unit 15 in such a manner that the two can be separated from each other.

The search unit 15 that has been connected to the command execution unit 13 can be replaced by another search unit by virtue of the search interface 14. The RDBMS 16 can be searched by utilizing a search unit that employs a search technique different from that of the search unit that has been connected to the command execution unit 13. It is assumed that the command execution unit 13 and search unit 15 have been manufactured by the same maker and that the user knows the procedure for reading data (transmitting data) between the command execution unit 13 and search unit 15. Even if the search unit 15 that has been connected to the command execution unit 13 is replaced by a new search unit, therefore, the user will know the procedure

by which reading between the new search unit and command execution unit 13 is performed. A search unit suited to the command execution unit 13 can be connected.

Similarly, a storage interface 17 is provided
5 between the command execution unit 13 and data storage unit 18. By thus providing the storage interface 17, the data storage unit 18 that has been connected to the command execution unit 13 can be replaced by another data storage unit.

10 An expression-format converter 20 is further connected to the storage interface 17. The expression-format converter 20 converts the size (resolution) of an image represented by image data (i.e., implements an expression-format conversion). Though the same subject
15 is represented by the conversion of expression format, image data representing a plurality of images of different sizes is generated. Image data representing a plurality of images generated by the expression-format converter 20 is written to the large-capacity hard disk
20 19 by the data storage unit 18.

Fig. 4 illustrates expression formats, which are converted by the expression-format converter 20, and the content of each format.

Examples of expression formats are Original (which
25 indicates original-image data); Card [an image of 300 × 300 pixels for a personal computer, this being JPEG (Joint Photographic Experts Group) data]; Thumbnail (an image of 80 × 80 pixels for a personal computer,

this being JPEG data); cellular phone A (cell phones A-1 to A-6) [GIF (Graphics Interchange Format) image data for cell phones]; cellular phone B (cell phones B-1 to B-4) [PNG (Portable Network Graphics) image data for
5 cell phones]; and Print (image data for print preview, this being JPEG data of 80 × 60 pixels).

The table regarding such expression formats has been stored beforehand in the expression-format converter 20. When image data is written to the large-
10 capacity hard disk 19, the original-image data is converted to the expression formats of the expression-format table that has been stored in the expression-format converter 20. The image data obtained by the conversion is written to the hard disk 19.

15 When image data having an expression format not present in the expression-format table that has been stored in the expression-format converter 20, the new expression format is stored in the expression-format table. If the image data is applied after the new
20 expression format is stored, this image data is converted so as to have the new expression format and is stored in the large-capacity hard disk 19. Accordingly, image data that has been written to the hard disk 19 is not necessarily image data corresponding to all
25 expression formats. Thus the types of expression formats stored differ for every image.

For example, if an image is one whose image identification number is No. 1, as shown in Fig. 5, then

image data having the expression formats Original, Card, Thumbnail, Cell Phone A-1, Cell Phone A-2 and Print (this image data represents substantially the same image of a subject and differs only in terms of image size)

- 5 will have been stored on the large-capacity hard disk 19. If an image is one whose image identification number is No. 2, then image data having the expression formats Original, Card, Cell Phone A-1, Cell Phone B-1, Cell Phone B-2 and Print will have been stored on the
- 10 large-capacity hard disk 19. If an image is one whose image identification number is No. 3, then image data having the expression formats Original, Thumbnail, Cell Phone B-1, Cell Phone B-2 and Print will have been stored on the large-capacity hard disk 19. It goes
- 15 without saying that at least image data having the Original expression format will have been stored on the hard disk 19.

Fig. 6 is a flowchart illustrating processing for searching image data.

- 20 If a search command transmitted from the client computer 1 is received by the command receiving unit 11 of the first database server 10 (step 31), as described above, then it is determined whether the received search command can be transferred to the other servers 2 and 3
- 25 (step 32). A search command is accompanied by data for the purpose of determining whether the search command can be transferred, and the determination as to whether the search command can be transferred is made based upon

the attached data.

If it is determined that transfer is possible ("YES" at step 32), then the search command is transferred to the servers 2 and 3 by the command resending unit 12 (step 33). If it is determined that transfer is not possible ("NO" at step 32), then the processing of step 33 is skipped.

Processing for searching image data is executed based upon the received search command (step 34). Image data is read out of the hard disk 19 by the search. The details of search processing will be described below. Processing for searching the image data is executed by the second database server 2 and third database server 3 as well and the results of this search are received by the command resending unit 12 of the first database server 10 ("YES" at step 35).

The results of the search by the first database server 10 and the results of the searches by the second database server 2 and third database server 3 are combined by the command execution unit 13 (step 36). More specifically, the items of retrieved image data are correlated in such a manner that the images represented by the image data obtained by the search results will be displayed in one window. The combined search results are transmitted from a result output unit 21 to the client computer 1 via the network. The images retrieved by the search are displayed on the display screen of the display unit of client computer 1.

The image data retrieved by the searches at the database servers 2 and 3 also are applied to the command execution unit 13. These results are combined in the command execution unit 13, as mentioned above, and
5 thumbnail images corresponding to the search command are displayed. Thus, by designating a single expression format, image data having this expression format is obtained with regard to all images that have been stored on the hard disk 19. Since the search command is
10 transferred to the other database servers 2 and 3 as well, many search results are obtained merely by applying a search command a single time.

Fig. 7 is a flowchart illustrating processing for command execution (this processing corresponds to that
15 of step 34 in Fig. 6).

The content of a received search command is interpreted by the command execution unit 13 (step 41). When the content of the search command is interpreted, the search unit 15 is detected (step 42), whereupon the
20 search unit 15 searches the RDBMS 16 based upon the search command (step 43). By searching the RDBMS 16, an image identification number corresponding to image data to be found is extracted.

Next, the data storage unit 18 is detected by the
25 command execution unit 13 (step 44). Data representing the extracted image identification number is applied to the data storage unit 18 via the search interface 14, command execution unit 13 and storage interface 17.

Image data corresponding to the extracted image identification number is read from the large-scale hard disk 19 by the data storage unit 18 (step 45).

Processing for reading (acquiring) image data will be
5 described later in greater detail. The image data read from the hard disk 19 is subjected to predetermined processing so as to be displayable (i.e., results are generated) (step 46).

Fig. 8 is a flowchart of processing for acquiring
10 data (this processing corresponds to that of step 45 in Fig. 7).

In which area of the hard disk 19 the image data corresponding to the extracted image identification number has been stored is detected from this image
15 identification number (i.e., the location of the data is determined) (step 51). The expression formats of the image data that has been stored in the detected area are checked.

If data having an expression format designated by
20 the search command is already present in the hard disk 19 ("YES" at step 52), then the image data having the corresponding expression format is read from the hard disk 19 (step 54).

If data having the designated expression format has
25 not been written to the hard disk 19 ("NO" at step 52), then the original-image data specified by the image identification number extracted from the RDBMS 16 is read from the hard disk 19. This read original-image

data is then applied to the expression-format converter
20, where it is converted to image data having the
designated expression format (step 53). A mark
indicating that the data has been obtained as the result
5 of a search is attached to the read image data (i.e.,
data is determined) (step 55).

For example, if the client computer 1 applies the
following as a search command: "SELECT IMAGE AS
THUMBNAIL FROM TABLE WHERE AGE = 35" (which means that
10 images of a record in which age agrees with 35 are to be
acquired in the thumbnail expression format), then the
attribute table that has been stored in the RDBMS 16 is
searched and identification numbers for which age agrees
with 35 are found. Data representing the identification
15 number of a found image is applied to the data storage
unit 18. From among items of image data corresponding
to the identification number of the found image, image
data having the thumbnail expression format is read by
the data storage unit 18. With regard to image data
20 that has not been stored on the hard disk 19 and has the
thumbnail expression format, the original-image data is
applied to the expression-format converter 20, which
proceeds to generate image data having the thumbnail
expression format. The read image data having the
25 thumbnail expression format and the generated image data
having the thumbnail expression format is applied to the
command execution unit 13.

Though the foregoing embodiment is described as

being implemented by hardware, it goes without saying that partial implementation by software is possible.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.